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(54) Liquid crystal display element

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(72) Inventor: Masayuki OKAMOTO

c/o Sharp Corporation

22-22 Nagaike-cho, Abeno-ku, Osaka

(71) Applicant: Sharp Corporation

22-22 Nagaike-cho, Abeno-ku, Osaka

(74) Representative: Patent Attorney Manahiko FUKUSHI and two others

Specification

1. Title of the Invention

Liquid crystal display element

2. Scope of Claim

1. A liquid crystal display element wherein one side of or both sides of a liquid

crystal layer are coated with a low resistance material so that an abnormal lighting phenomena caused by static electricity can be controlled.

3. Detailed Description of the Invention

[Technical Field]

The present invention relates to a liquid crystal display element for which a means to control an abnormal lighting phenomena caused by static electricity is provided.

[Prior Art]

Conventionally, a liquid crystal display element is often used as a display body that is small and consumes less power. Especially, a field-effect liquid crystal display element using twisted nematic liquid crystal (TNFEM liquid crystal display element) is the mainstream of a display body for a watch, a calculator and the like. Fig. 1 is a side face cross-sectional view to show a schematic structure of a usual TNFEM liquid crystal display element. In this figure, reference numeral 1 is a substrate made of glass or the like, reference numeral 2 is an ITO film (transparent electrode) on the substrate 1 for coating, formed by deposition, sputtering and the like. Reference numeral 3 is an orientation film formed on the ITO film for coating, 4 is a spacer, reference numeral 5 is liquid crystal, reference numeral 6 is a seal, reference numeral 7 is a polarizing plate that is provided on the outer side of the above-mentioned substrate 1, and reference numeral 8 is a reflecting plate. When the surface of the conventional polarizing plate 7 of a TNFEM liquid crystal display element with a structure as above is rubbed with a finger, a cloth or the like, static electricity is generated, and electrification is induced in the inner side of the substrate 1 by the generated static electricity. In addition, in the case where the electric charge is excessive, liquid crystal molecules are excited due to the electrification in the ITO film 2 on the inner side of the substrate 1, which causes

erroneous lighting.

[Object]

The present invention is to solve the conventional problem based on static electricity generation described above, and the object of the invention is to prevent excessive electrification due to the generation of the static electricity and prevent erroneous lighting of a liquid crystal display element from occurring.

[Embodiments]

An embodiment of a liquid crystal display element of the present invention will be described in detail, referring to drawings.

Fig. 2 is a side face cross-sectional view to show a schematic structure of the first embodiment of a liquid crystal display element of the present invention. In this figure, the same portions as in Fig. 1 are indicated by the same symbols. In this figure, reference numeral 9 is a low resistance substrate. The low resistance substrate 9 is a substrate made by mixing conductive particles such as metal particles and carbon particles (carbon black) into a transparent material such as glass and plastic, or a substrate made by mixing a charge-transfer complex such as tetracyanoquinodimethane (TCNQ) and polysulfone nitride ($(SN)_2$) into transparent plastic. Reference numeral 10 is an insulating film such as SiO_2 to insulate the inner side of the above-mentioned low resistance substrate 9. The resistance value of the substrate 9 is lowered by the existence of the above-mentioned materials mixed. This resistance value depends on the amount of the material mixed, and as long as the volume resistance value of the substrate 9 is 10^8 Ω cm or less and the surface resistance value is 10^8 Ω or less, excessive electrification can be prevented. The reason why the excessive electrification can be prevented is considered to be as follows: in the case where the substrate has low resistance, even when static electricity is generated by rubbing the surface of the polarizing plate 7 with a finger, a cloth or the like, the electric charge is dispersed on the

substrate surface and excessive electric charge doesn't occur partially; furthermore, the electric charge is diffused to the air even when the static electricity is generated, so that the electric charge is hardly stored on the substrate surface. When the low resistance substrate 9 on the upper side and the low resistance substrate 9 on the under side are connected electrically, the low resistance substrate 9 on the upper side and the low resistance substrate 9 on the under side have the same electric potential, which means the inside of the substrates is covered by objects having the same electric potential, and the effect of preventing the static electricity described above is improved. In addition, when either one of or both of the low resistance substrates 9 are connected to ground, the effect of preventing the static electricity described above is improved further.

Fig. 3(a) is a side face cross-sectional view to show a schematic structure of the second embodiment of a liquid crystal display element of the present invention. In this figure, the same portions as in Fig. 1 are indicated by the same symbols. In this figure, 11 is a low resistance film such as an ITO film formed on a substrate 1 made of glass, plastic or the like, for example, by deposition, sputtering or the like. As for the resistance value of this low resistance film 11, as long as the area resistance value is 10^8 Ω/□ or less, excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment. The advantage of the structure in which the low resistance film 11 on the upper side substrate 1 and the low resistance film 11 on the under side substrate 1 have the same electric potential, and the advantage of the structure in which either one of or both of the low resistance film 11 on the upper side substrate 1 and the low resistance film 11 on the under side substrate 1 are connected to ground are the same as the first embodiment. Fig. 3(b) shows a transformation of the second embodiment described above, in which a low resistance film 11 is formed on the inner face of a substrate 1 and the low resistance film 11 is coated with an insulating film 12 made of SiO_2 or the like so as to be insulated. With this structure, since the low resistance film 11 is kept airtight, the diffusion of electric charge to the air cannot be expected much. However, when the structure in which the

low resistance film 11 on the inner face of the upper side substrate 1 and the low resistance film 11 on the inner face of the under side substrate 1 are connected electrically so as to have the same electric potential, or the structure in which either one of or both of the low resistance film 11 on the inner face of the upper side substrate 1 and the low resistance film on the inner face of the under side substrate 1 are connected to ground is applied, the effect of static electricity on a liquid crystal layer can be prevented well. In embodiments below, these structures can also be applied. Fig. 3(c) shows another transformation of the second embodiment described above, in which low resistance films 11 such as an ITO film are formed on the outer faces and the inner faces of the substrates 1.

Fig. 4 is a side face cross-sectional view to show a schematic structure of the third embodiment of a liquid crystal display element of the present invention. In this figure, the same portions as in Fig. 1 are indicated by the same symbols. In this figure, 13 is a moisture absorption layer such as a silica gel film and a surface active agent (alkylphosphate ester sodium or the like) that coats the outer side of a substrate 1 and a polarizing plate 7. The surface resistance of the moisture absorption layer 13 becomes 10^8 Ω or less due to the moisture absorption function, so that excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment.

Fig. 5 is a side face cross-sectional view to show a schematic structure of the fourth embodiment of a liquid crystal display element of the present invention. In this figure, the same portions as in Fig. 1 are indicated by the same symbols. In this figure, 14 is a low resistance paste layer which is formed on the surface of a substrate 1 for coating, and this low resistance paste layer 14 is a paste layer made by mixing a charge-transfer complex such as tetracyanoquinodimethane (TCNQ) and polysulfone nitride ($(SN)_2$). As for the resistance value of the low resistance paste layer 14, as long as the volume resistance is 10^8 Ω cm or less, excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first

embodiment.

Fig. 6 is a side face cross-sectional view to show a schematic structure of the fifth embodiment of a liquid crystal display element of the present invention. In this figure, the same portions as in Fig. 1 are indicated by the same symbols. In this figure, reference numeral 15 is a mesh metal plate made of stainless-steel, and reference numeral 16 is a metallic reflecting plate. Since the metal plate 15 has a shape of mesh, what is displayed can be seen well enough through the openings of the mesh. By the above-mentioned mesh metal plate 15 and the metallic reflecting plate 16, each surface of liquid crystal 5 is coated with extremely low resistors, and excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment.

Fig. 7 is a side face cross-sectional view to show a schematic structure of the sixth embodiment of a liquid crystal display element of the present invention. In this figure, reference numeral 17 is a low resistance plate-like body made of a transparent body such as an acrylic coated with an ITO film by deposition, sputtering or the like. When the low resistance plate-like body 17 is connected to ground, static electricity can be diffused effectively.

Fig. 8 is a side face cross-sectional view to show a structure of a polarizing plate portion of the seventh embodiment of a liquid crystal display element of the present invention. In this figure, the structure except the polarizing plate is the same as Fig. 1. In Fig. 8, reference numeral 18 is a protecting layer, reference numeral 19 is a binding agent, reference numeral 20 is a polarizing layer, and reference numeral 21 is an adhesive to perform adhesion to a liquid crystal cell. By mixing conductive particles such as metal particles and carbon particles (carbon black) or a charge-transfer complex such as tetracyanoquinodimethane (TCNQ) and polysulfone nitride ($(SN)_x$) into at least one layer of (it can be two layers or more of) the above-mentioned protecting layer 18, the binding agent 19, the polarizing layer 20 and the adhesive 21, the volume resistance is set to be 10^8 Ω cm or less. With this structure, excessive electrification is prevented.

The reason why the excessive electrification can be prevented is the same as the first embodiment.

Fig. 9 is a side face cross-sectional view to show a structure of a polarizing plate portion of the eighth embodiment of a liquid crystal display element of the present invention. In this figure, the structure except the polarizing plate is the same as Fig. 1. In Fig. 9, reference numeral 22 is a protecting layer, reference numeral 23 is a binding agent, reference numeral 24 is a polarizing layer, and reference numeral 25 is an adhesive to perform adhesion to a liquid crystal cell. Reference numeral 26 is a moisture absorption layer such as a silica gel film and a surface active agent (alkylphosphate ester sodium or the like) formed on the protecting layer 22 on the upper side for coating. The surface resistance of the moisture absorption layer 26 becomes 10^8 Ω or less due to the moisture absorption function, and excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment.

Fig. 10 is a side face cross-sectional view to show a structure of a polarizing plate portion of the ninth embodiment of a liquid crystal display element of the present invention. In this figure, the structure except the polarizing plate is the same as Fig. 1. In addition, the same portions as in Fig. 9 are indicated by the same symbols. Reference numeral 27 is a low resistance film such as an ITO film formed on a protecting layer 22 on the upper side by deposition, sputtering or the like for coating. As for the resistance value of the low resistance film 27, as long as the area resistance is 10 Ω/□ or less, excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment.

Fig. 11 is a side face cross-sectional view to show a structure of a polarizing plate portion of the tenth embodiment of a liquid crystal display element of the present invention. In this figure, the structure except the polarizing plate is the same as Fig. 1. In addition, the same portions as in Fig. 9 are indicated by the same symbols. Reference numeral 28 is a low resistance paste layer formed on a protecting layer 22 on

the upper side for coating, and this low resistance paste layer 28 is a paste layer made by mixing a charge-transfer complex such as tetracyanoquinodimethane (TCNQ) and polysulfone nitride ($(SN)_x$). As for the resistance value of the low resistance paste layer 28, as long as the volume resistance is 10^8 Ω cm or less, excessive electrification can be prevented. The reason why the excessive electrification can be prevented is the same as the first embodiment.

[Effect]

According to the present invention described in detail above, by coating one side of or both sides of a liquid crystal layer with a low resistance material, excessive electrification due to static electricity doesn't occur in an electrode having contact with the liquid crystal layer, and an abnormal lighting phenomena can be prevented.

4. Brief Description of Drawings

Fig. 1 is a side face cross-sectional view to show a schematic structure of a conventional TNFEM liquid crystal display element. Fig. 2 is a side face cross-sectional view to show a schematic structure of the first embodiment of a liquid crystal display element of the present invention. Fig. 3(a) is a side face cross-sectional view to show a schematic structure of the second embodiment of a liquid crystal display element of the present invention, Fig. 3(b) is a side face cross-sectional view to show a schematic structure of a transformation example of the second embodiment, and Fig. 3(c) is a side face cross-sectional view to show a schematic structure of another transformation example. Fig. 4 is a side face cross-sectional view to show a schematic structure of the third embodiment of a liquid crystal display element of the present invention. Fig. 5 is a side face cross-sectional view to show a schematic structure of the fourth embodiment of a liquid crystal display element of the present invention. Fig. 6 is a side face cross-sectional view to show a schematic structure of the fifth embodiment of a liquid crystal display element of the present invention. Fig. 7 is a side

face cross-sectional view to show a schematic structure of the sixth embodiment of a liquid crystal display element of the present invention. Fig. 8 is a side face cross-sectional view to show a structure of a polarizing plate portion of the seventh embodiment of a liquid crystal display element of the present invention. Fig. 9 is a side face cross-sectional view to show a structure of a polarizing plate portion of the eighth embodiment of a liquid crystal display element of the present invention. Fig. 10 is a side face cross-sectional view to show a structure of a polarizing plate portion of the ninth embodiment of a liquid crystal display element of the present invention. Fig. 11 is a side face cross-sectional view to show a structure of a polarizing plate portion of the tenth embodiment of a liquid crystal display element of the present invention.

In the drawings, each numeric character indicates as follows:

1: substrate, 2: ITO film, 3: orientation film, 4: spacer, 5: liquid crystal, 6: seal, 7: polarizing plate, 8: reflecting plate, 9: low resistance substrate, 10: insulating film, 11: low resistance film, 12: insulating film, 13: moisture absorption layer, 14: low resistance paste layer, 15: metal plate, 16: reflecting plate, 17: low resistance plate-like body, 18: protecting layer, 19: biding agent, 20: polarizing layer, 21: adhesive, 22: protecting layer, 23: binding agent, 24: polarizing layer, 25: adhesive, 26: moisture absorption layer, 27: low resistance film, 28: low resistance paste layer

Representative: Patent Attorney Manahiko FUKUSHI and two others

Applicant: Sharp Corporation